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(Author)

What's the Buzz? Tell Me What's Happening!
Developing Ownership of Understanding in
Mathematics Education

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Developing Ownership of Understanding in
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ABSTRACT

Beneath the banalities of buzzwords lies a syntax of philosophical traditions that have pedagogical impact on how we willingly or unwittingly conduct ourselves as educators. This paper presents an analytic review of two contrasting educational philosophies and their corresponding learning outcomes. Questions will be raised concerning the schism that exists between teacher-centered and student-centered approaches, and their implications to concepts central to education such as accountability, ownership of understanding and responsibility. Finally we present an argument of how a rational policy of homework may be able to bring about goals consistent with current reform initiatives, without radically altering curriculum or pedagogy.

INTRODUCTION

Buzzword is an important-sounding word or phrase generally of little meaning used primarily to impress "laymen"(sic) according to Webster's Collegiate Dictionary. Perhaps it is revealing that a "buzzer", in olden times, was a whisperer of rumors or secrets; hence to catch the "buzz" was to be privy to a whispered report (Evans, 1989). However, the claim of this paper is that what some (novice, layperson?) might regard as banalities, buzz words or jargon, serve as lens for others through which the make-up of a social institution is, in part, revealed. Our claim is that the vocabulary of the social sciences describes a peculiar and distinct order of reality, both invented and historical, but nevertheless factitious, and that vocabulary has a syntax which links all the social sciences, permitting us to reconstruct the reality of social facts in understanding.

Accountability, autonomy, authentic assessment, teacher-centered, student-centered, and constructivism are terms that have gotten much wear in recent years. Perhaps to many, they have even worn out their welcome. It is our purpose to provide an analytic review of these and related "buzzwords" and demonstrate their centrality to educational philosophy and pedagogy. "Buried beneath the apparent 'plain speak' are metaphoric, theoretical, and empirical traditions, which position and deepen the text for the social scientist" (Richardson, 1990, p.34).

The pedagogy of teacher-as-facilitator is not new to the school of education. Its pedagogical roots are evident in Socratic inquiry. Yet, the absence of its pedagogical presence in contemporary classrooms poses a professional development nightmare. In the wake of intense reform initiatives to implement a student-centered orientation of learning, how will teachers receive the training necessary to implement the recommended changes? The issue may be change itself. From this, it seems necessary to advance change without radically altering curriculum or pedagogy. We believe that the desired change can be advanced through homework. Educators from all content areas, particularly mathematics and science because of their adherence to teacher-centered pedagogy, should incorporate a homework policy that is consistent with student-centered principles. Moreover, failure to incorporate an appropriate homework model will result in, at best, pretentious lip service to current reform initiatives and, at worst, a

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noticeably stagnant inability of teachers to design and provide instructional strategies and learning environments for the needs of their students. Furthermore, failure to recognize the importance of homework, in relation to the student-centered classroom, deprives the classroom teacher of the opportunity to fully implement the philosophical, psychological, and pedagogical benefits of autonomous learning, responsibility, and ownership of understanding.

FAITH AND DEED

The expected outcome of education is knowledge. A subset of this outcome is learning from teaching. In this subset, the means to the ends of knowledge are instructional methodologies. Today, the legacy of the teacher-centered, social behaviorist's pedagogical perspective [e.g.: Johann Herbart (1776-1841); Wilhelm Wundt (1832-1920); Edward Thorndike (1874-1949)] of transferring generalized knowledge through pre-determined, outcome-based objectives is not conducive to extending knowledge. Their theoretical framework is satisfied with content coverage, when mastery of objectives through skillful use of algorithms has been accomplished and measured by criterion-referenced exams. In this mastery learning approach the analysis of outcomes precedes the learning experience.

The student-centered, experientialist orientation [e.g.: Friedrich Froebel (1782-1852); Francis Parker (1837-1902); John Dewey (1859-1952)] has little of the social behaviorist's pre-determined goals or expected outcomes. Without adherence to pre-determined outcomes there are no limits to what knowledge results. The social behaviorist is satisfied when learning has occurred while the experientialist pursues a deeper understanding, constantly working in the student's zone of proximal development (Vygotsky, 1978).

The traditional, social behaviorist classroom student has faith in what the teacher knows and believes what the teacher teaches. The progressive, experiential classroom student constructs an ownership of understanding by deed and believes what experience teaches.

In short, the debate between social behaviorist (with their adherence to measurement, precision, efficiency, and mechanical technique) and experientialist (with their child-centered, democratic, effective, problem-solving orientation) pitted formal science against investigative science. The social behaviorist sought controls through generalized knowledge by credentialed experts while the experientialist explored through inquiry, with

others, for insights into experiences that may not yet be known (Schubert, 1986).

Round Multiple Learning Styles in Square Learning Environments.

Do teachers in today's classrooms try to fit round pegs into square holes? Gardner (1983) has collected many supporters of his theoretical perspective of multiple intelligences and perhaps alerted or reminded teachers that students (in fact, people in general) learn differently. Perhaps instead of the teacher selecting the "way" students learn, students themselves should direct and advance their particular learning style, thus insuring an appropriate match of learner and learning style. The social behaviorist cannot relinquish the learning process to the student since their framework depends on the transfer of their knowledge to their students. The experientialist framework is conducive to the pupil becoming the teacher since the teacher is also a participant in the learning process.

Ask a student from each orientation (social behaviorist=SB, and experiential=E) these three questions, "What do you know?", "How did you come to know it?", and "How do you know you know it?". The responses may be the same for the first question but will be quite different for the last two. To question two, the SB student would answer, "My teacher taught it to me.", while the E student would say, "By doing it.". The answer to the third question from the SB student might very well be, "I got an 'A' on my test.", and from the E student, "I built it myself.", or, "It works.".

Efficient or Effective Pedagogy:

Algorithmic Learning or Conceptual Understanding?

Often associated with these educational orientations is the debate of whether teachers should teach the algorithms of concepts or have students derive algorithms with their understanding of the concept. "Faith" would argue that efficient use of time is the deciding factor in giving the student the algorithm and understanding the concept is something that will develop if the student is able and genuinely interested in learning its derivation. This efficient use of time allows students to be introduced to many other algorithms and indoctrination to more algorithms is more knowledge. We hesitate to call this teaching and would distinguish it as indoctrination. This is a term that Green (1971) contrasts against teaching, in the context of beliefs. Indoctrination develops beliefs non-evidentially (faith) while teaching does so evidentially (deed or reason). The difference is not necessarily in the ends

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of beliefs, but rather the means by which they are developed. "In short, even though the beliefs one holds are true, one cannot be said to know they are true, if they are believed in this non-evidential fashion" (p. 299).

"Deed" believes that if students explore a concept, discover a pattern or relationship, and derive a corresponding algorithm, that it is understanding owned by the student. Ownership of understanding may be more time-consuming but is justified by the experientialist's belief that it is "better" (effective) learning. "Faith" believes that teaching the skillful use of algorithms is efficient learning. However, "To focus simply upon securing a right solution without understanding the nature of mathematical operations is the mathematical equivalent of indoctrination" (Green, 1971, p. 303). Parenthetically, we should point out that while we believe depth of study to be important, we know of no research which asserts its preference over breadth in establishing a knowledge base The central question for educators to raise is, "What kind of learning do we wish to teach?".

The issue is really learning itself. There is no determinant that students in teacher-centered classrooms will be learners because student activity is covert. "Deed" will argue that passivity is not natural or conducive to learning. Activity, or learning from experience, is more likely to involve the student in the learning process and is overt. "Deed" believes that learning from experience is more natural because it is how we tend to learn, in general. In both orientations learning involves sensory perceptions. In the experiential camp there are, arguably, more senses involved.

Learning in the social behaviorist model is often transferred from the teacher to the student by lecture and drill with an emphasis on skills, but what is involved in learning from experience? Shulman (1989) points out there are two obvious (yet possibly difficult to achieve) requirements - knowing what you did and identifying the consequences. Learning from experience requires careful attention to trials and their resultant errors. Trial and error can be very frustrating to learners, especially young learners. They can easily exhaust possible means in search of desired ends, or reach their desired ends while forgetting which means were used.

The social behaviorist methodology is an efficient way to teach a lesson and is the dominant pedagogical paradigm (Goodlad, 1984). The social behaviorist model is considered to be an efficient one because there are very few mistakes. In this model the teacher transfers their knowledge to their

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students, often through lecture. The teacher chooses the shape of the lesson and, by so doing, effects and directs the "way" in which students learn.

The inefficiency of the experiential model, or the learner-centered classroom, is often considered to be the enormous quantity of mistakes students make in constructing understanding. However, it is precisely during mistakes where proponents of the experiential model claim that students (in fact, people in general) actually begin to understand.

The experientialist argues that the social behaviorist model is efficient but only indoctrinates students, it does not teach them. The experientialist adds that theirs is a better model of teaching because it naturally corresponds to the "way" students learn. Dewey (1957) defends this perspective stating, "Few men would purchase even a high amount of efficient action along definite lines at the price of monotony, or if success in action were bought by all abandonment of personal preference" (p. 279).

If the difference between faith and deed is learning efficiently or effectively, then as a teacher educator, ask yourself this question, "Would I rather learn efficiently or effectively?". Effective learning is understanding. Efficient understanding is an oxymoron. We do not believe the adjective (efficient) can modify the noun (understanding). However, there is efficient learning and learning is not a bad outcome - which is probably why its use is so widespread.

Are there particular schools that favor faith or deed? College preparatory schools with their strict dependence on the outcomes of SAT scores are generally associated with the social behaviorist model while vocational education is often thought to espouse the experientialist model. Each association is determined primarily by the activities and teaching methods used in the classroom. Vocational courses differ from academic courses because vocational course students are about twice as likely to have used some kind of instrument, tool or equipment, and computer than academic course students (Heaviside, 1994). In addition, vocational teachers were more likely to administer a performance test or assess a student's portfolio than academic teachers since occupational skills were significantly more likely to contribute to a vocational student's grade. Interestingly, homework was much more likely to be assigned in an academic class (95%) than in a vocational class (59%).

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AUTONOMY AND RESPONSIBILITY

The purpose of education, as proposed by the great philosophers of Western traditions (e.g. Plato, Bacon, Hobbes, Descartes, Spinoza, Locke, Rousseau, Kant, Hegel and others), is to enable the development of the individual and society. Undeniably, the philosophical mission of preparing students to become responsible citizens advances this purpose of education.

What are the criteria for developing responsibility in the learner? There are learners that are not autonomous and learning can certainly take place without learner autonomy. However, our claim, for teachers to consider, is that there exists a region of responsibility that is created only through "deed" when the learner is autonomous. The autonomous learner is independent and self-governing, and this freedom is essential in developing responsibility. This region stands in stark contrast to the region of accountability which is teacher-driven and exacts, as its cost, "faith" from the student. Without autonomy the learner cannot become responsible. Figure one below illustrates this central claim:

Figure 1.   CONCEPTUAL ANALYSIS: Instructional Methodologies
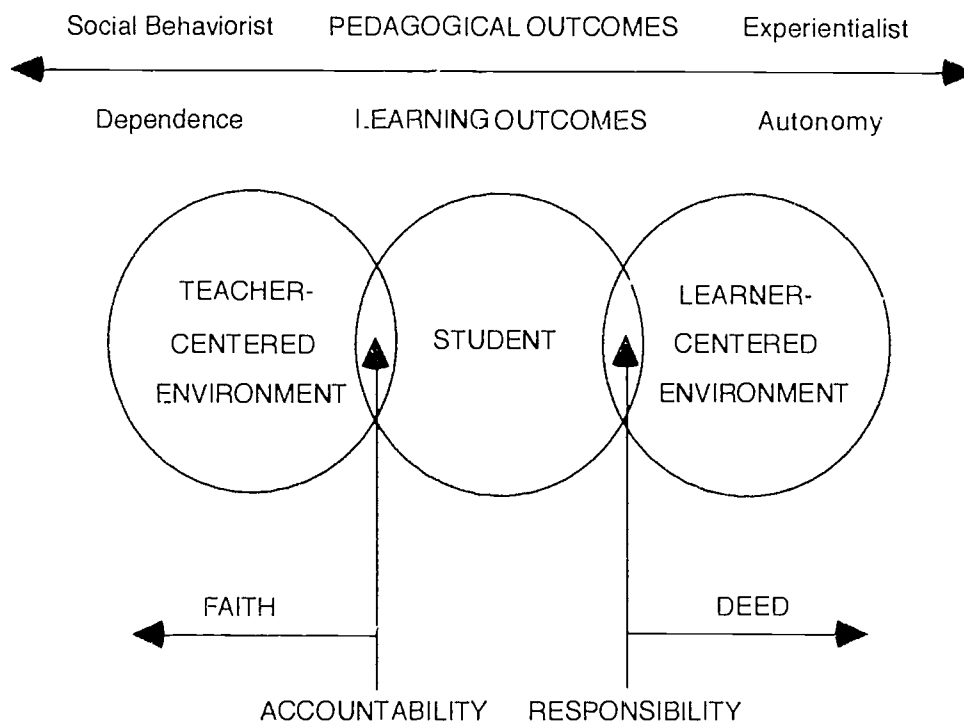
Nowhere, in any content area, are learners more autonomous than during homework. This is particularly true in mathematics and to a lesser extent in science. It is during homework that the learner can reinforce content and internalize concepts. Homework also provides an opportunity for learners to isolate points of confusion as they construct an ownership of understanding. Polya (1988) underscores the importance of autonomy by stating that the "student should acquire as much experience of independent work as possible" (p. 1).

Does merely assigning homework mean that teachers are providing a window of opportunity for students to act responsibly? Not necessarily. Mathematics teachers spend a great deal of class time going over homework. This raises speculation about the reasonableness of the homework, the quality of the lesson which preceded the homework, or perhaps the students' accustomed dependence on the teacher for presenting solutions to the homework. If the student is accustomed to relying on the teacher for reviewing the homework, the learner is not autonomous and therefore responsibility is not being developed.

Accountability or Responsibility?

This is a point where another schism between the social behaviorist and experientialist occurs. What motivates a student to do homework? The fundamental principle of the social behaviorist's stimulus-response framework is control. Behavior in S-R theory is controlled by rewards. The social behaviorist student is motivated to do homework because of a grade. Success in a social behaviorist classroom is measured by an accounting of student rewards (grades). Students motivated by rewards are not being taught responsibility. Grading, as a motivator, holds students accountable for doing homework, and increases their dependence on the teacher's quest for accountability. Does the grade a student receives measure their responsibility? Responsibility can be the source or cause of behavior, but in this case the grade controls the behavior. This is more appropriately described by accountability. Accountability can explain behavior but cannot be the source or cause of the behavior, it must rely on a mediating factor, in th's case grades, which associates the causal relation.

In the experientialist classroom, evaluation of progress involves multiple assessments through portfolios of student work. The student, their parents, peers, and teacher can all become involved in the assessment

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strategy. There are several types of assessment formats, some of which are; Journals: which give the teacher insights into student understanding, Research Projects: individual or group, Performance: demonstrations of student abilities, and Problem Solving: non-routine problems that challenge curiosity and creativity. The student has the responsibility of providing input into what will be included in their portfolio, which should document their mathematical growth. Success in an experiential classroom is measured by the growth of the student. It is very difficult to put a grade on such an individualized basis. This leads to the question of whether grades measure capability. Is a student that gets good grades on criterion-referenced exams, proving mastery of outcome-based objectives, necessarily capable? What do grades mean? Do the grades from one school correspond to similar grades from another? These questions are beyond the scope of this paper. However, the answers may be available at college admissions offices. Imagine how awkward it would be for college admissions people to screen applicants using their portfolios instead of their SATs!

FLOTSAM AND JETSAM

The literature surrounding the varied philosophical approaches of assigning, correcting, and assessing homework confuses the purpose, relevance, and importance of homework. A question always arises when reviewing the literature as to what we wish to salvage from it and what should be jettisoned. At this point we then cautiously attempt to deduce or infer the "open questions". The literature tells us much about homework and responsibility by telling us very little. Minor, if any, attention is devoted to homework as a vehicle for developing autonomous learners. Therefore it is quite clear, from the lack of literature, that there is virtually no homework model which addresses the development of student responsibility. A brief verview of characteristic studies provides an evidentiary base from which our final pedagogical claims will be derived.

Homework: Policy or Curriculum?

In the Los Angeles Unified School District (1990), policy guidelines for assigning homework are provided as a part of the lesson planning and instruction of mathematics and science electives. Although the guidelines are general and their interpretations may vary somewhat from teacher to teacher the appearance of a homework philosophy is purposeful. The guidelines suggest ends but are unclear as to the means to be used to reach

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those ends. For example, "Daily homework assignments are important resources for teachers in helping students learn" (p. 24). No one would deny this as an appropriate end, but by which means does this become accomplished? Consider these additional statements: "Students should not be given homework assignments they have not been taught how to do; When appropriately assigned and explained by the teacher, homework becomes the responsibility of the student to understand" (p.24). Inasmuch as this view of homework is clearly teacher-centered, accountability and indoctrination result, not responsibility and understanding. The teacher produces dependence and faith as a learning outcome. This is contrary to the kind of student responsibility that develops from deed in the autonomous learner.

The Cleveland Collaborative for Mathematics Education (C2ME) used homework as the curriculum. The C2ME intended to change the role and status of teachers of mathematics. "This curriculum was characterized by directed lessons with coverage of content held to the minimum...Homework is the mathematics lesson" (Bruckerhoff, 1⸳⸳⸳9, pp. 43-44). In this project the definition of homework has changed. It is something done in class from the beginning bell to the ending bell as well as at home. Bruckerhoff suggests that the homework curriculum helps students learn mathematics, but was concerned with what kind of mathematics was being taught and how it was being learned.

Sequential mathematics for grades 9-11, which extends the integrated K-8 curriculum, governed by the New York City Board of Education, interweaves algebra, geometry, logic, probability, statistics, and trigonometry. The lessons involve a motivational activity, generally related to the students' experiences (Bresnan, 1985). This activity appears to have an experientialist flavor, developing critical thinking skills through applications, and performance objectives, however the homework is primarily drill and practice designed to reinforce the specific goals and objectives.

The New York City Board of Education (1987a, 1987b) has produced materials from workshop sessions which include, homework planning and review to maximize student learning, designed for new teachers of mathematics. The emphasis is on planning and significance of homework with regard to instructional goals. This material suggests that careful

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consideration be given when assigning homework. What type of consideration is left to the teacher to determine.

The literature tells us very little about homework in an experiential setting. The primary focus of homework appears to be reinforcing content through drill and practice. The current philosophical state of homework does not develop student responsibility, it develops student dependence. The bulk of the literature is devoted to how the teacher should go over, or manage going over, the homework, not the student. The student learns very quickly in the mathematics classroom that attempting to do homework is su. cient, since credit is given for effort, not understanding, and whatever effort is made, the teacher will go over the homework questions in class. This allows or teaches students to attempt just enough to get credit for doing the homework and it teaches students nothing about their self-governing control in gaining ownership of understanding. The student also learns that homework is likely not to be collected and evaluated, removing purpose and importance from doing the homework. The teacher should reflect on the question, "Why are there so many questions on the homework?", and determine the answer.

Overlooked and possibly discarded in the literature was mention of homework as it relates to pedagogy. Virtually no reference to homework regarding learning styles was discussed. The noticeable absence of the "homework-learning style" relationship is puzzling. If learning styles are admittedly as multiple as there are learners, why not gear the homework assignment to each type of learner? People learn differently, so why not adapt the homework to match the individual's learning style? If management is a concern of not fully implementing multiple teaching styles to accommodate multiple learning styles in the classroom, perhaps it would be appropriate to capitalize on homework as an opportunity to match the learner to their learning style.

Teaching and Learning

Bloom (et al., 1981) suggests that evaluation can be used to improve learning. The evaluation (homework, quizzes, tests, etc.) is the motivating factor for the student to do their work. This is referred to as "teaching by testing". Posamentier and Stepelman (1990) concur that extrinsic motivation induced by the expectation of a quiz is a useful factor in the learning process, but caution that this should not be done for punitive reasons and should be

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used sparingly to determine the level of mastery of a particular homework assignment. Motivation from sources external to the student is also derived from teachers' practices of collecting and grading homework. Columba and Dolgos (1993) are also among the many who espouse the social behaviorist perspective to homework. They present a "drill-and-review" process in which students take daily quizzes and then correct each other's work.

The rationale used by teachers relative to grading homework varies from teacher to teacher. Some teachers do not grade homework but give credit to the student for attempting to accomplish it. The grading of homework is often the motivation for the student doing the homework. However, as Ropp (1992) points out, "collecting homework takes it away from the student and makes mountains of paper work for the teacher" (p. 536). Ropp's solution to the "homework dilemma" is to use a homework scorecard where students receive a '5' for a complete assignment (not necessarily a correct one), a '1' for an incomplete assignment, and a '0' for no attempt at all. "Although a perfect score on a test may be difficult to achieve, a perfect homework score is possible for all students" (p. 536). Notice here that students can get a perfect homework grade for just attempting it, yet their test scores will not necessarily reflect their doing the homework. So much for motivating the student to do homework to gain ownership of understanding or improve test scores.

Stanulonis (1992) uses a similar scorecard to record homework. One difference being that the students keep track of their grades as well as the teacher. She believes this method is a motivational technique and teaches responsibility. We hesitate to think that responsibility is being taught. Perhaps she is teaching accountability since responsible students do not need to be grade-motivated to do homework.

Marquis (1989) reminds us that problems should be carefully chosen with a purpose in mind. When teachers assign "page 32, 1-31 odd", for example, they may be "sending a message to students that no thought was given to the selection of particular problems, implying that none are particularly essential, important, or meaningful" (p. 423). In addition, she recommends that a system of accountability motivates and interests students because of its variety. This system includes collecting and grading random homework assignments, giving frequent quizzes, and giving open-notebook quizzes. The idea behind this frequent quiz and test strategy is one where the

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student is rewarded for doing the homework. The grades are the motivating factor. Grades as motivators to do homework, that extend to include frequent evaluations based on the homework, are often interpreted as measuring learning. "Good" grades are often associated with "good" learning. This is the "teaching by testing" method in all its glory.

It seems clear that homework is a part of how teachers expect students to learn mathematics. If the activity of a mathematics classroom exposes students to a concept, and examples of exercises which apply an algorithm to the concept are demonstrated by the teacher at the chalkboard, homework becomes a culminating event. In the 15-30 exercises which are assigned for homework, students repetitively invoke the algorithm of the day to master the concept. Using this mastery learning approach there is a concentrated focus on that particular algorithm, as it relates to the concept, with little connection made to last week's or yesterday's concept. This approach to teaching is algorithmic and establishes field dependence. This is not problem-solving, it is exercise-solving. This is the social behaviorist's homework perspective, not the experientialist's. It appears to be the dominant use of homework but is it the best use?

Spending more time teaching is more time available for influencing learning. The more time students spend in school appears to directly affect learning. Research (Goodlad, 1984) shows the amount of time spent on a given subject (particularly core subjects like mathematics and science) is a powerful factor in learning. Is spending more time on homework beneficial to learning?

Data (OERI, 1986) on the time spent on mathematics instruction and homework were collected from 20 countries. Japanese students ranked first in all mathematics content areas. Regarding homework, 95% of the Japanese teachers represented that their students did less than three hours of homework per week, while 83% of the United States teachers believed that their students did greater than three hours of homework per week. In addition, 12% of United States students did not do homework, in contrast to only 3% of Japanese students not doing homework.

Time spent on learning seems to be dramatically different between Asian students and American students. Stephenson (1983) conducted a study of school achievement in Japan, Taiwan, and the United States. In his comparative study, he asked the students' mothers if luck, ability, or effort

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were the critical factors underlying achievement. He reports that Asian mothers said effort while U.S. moms said ability. (Hard work leads to success?)

We have seen many uses of homework in the review of the literature, but what about homework for enrichment, or enhancement of understanding? Can homework extend learning to include specific areas of individual or group interests? What about homework as research, as an advanced organizer or as a means of discovery? To consider such questions requires careful thought and visionary perspectives for the future of education.

RATIONAL RUMINATIONS: A LOOK FORWARD

Faith or Deed? Algorithmic Learning or Conceptual Understanding? The principles at the very heart of the Massachusetts Education Reform Act, as expressed in the Curriculum Frameworks and Common Chapters (1995), communicate that curriculum should be based on a constructivist philosophy advanced through instructional techniques involving inquiry, problem-solving, discovery, and conceptual application. This suggests a shift from the traditional teacher-centered classroom to one which is learner-centered. This pedagogical shift positions the student as an active agent central to the learning process and repositions the teacher as a facilitator of knowledge.

The pedagogy of teacher-as-facilitator is not new to teacher educators. Its pedagogical roots are evident in Socratic inquiry. Yet, the absence of its pedagogical presence in contemporary classrooms raises concerns. The concerns suggest that its theory is unfamiliar to, or misinterpreted by educators, or its application is not practical. The absence of teacher-as-facilitator from the pedagogical scene could also result from a reluctance of teachers to change their educational practices.

If the concept of facilitator is misunderstood, perhaps replacing it with the "buzzword" of <u>learning manager</u> will connote a more familiar or practical concept. A learning manager is not necessarily the primary source of knowledge. Through assessment a learning manager diagnoses student needs, identifies and selects appropriate learning objectives, selects and organizes learning experiences, and measures students' progress toward the learning objectives (Tyler, 1950). This authentic assessment of progress identifies student needs returning the learner manager to the beginning of the teaching-learning cycle. As we talk about authentic assessment, we

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should consider authentic teaching and authentic learning. When considering authentic teaching and learning, in the context of authentic assessment, educators should decide whether we want our students to "reproduce" or "produce" knowledge (Newman, 1991).

A question immediately surfaces. Is it sometimes necessary to teach just an algorithm, and not the concept, because the conceptual understanding does not exist? Regardless of which pedagogical orientation of schooling a teacher assumes, is it possible to teach an algorithm without understanding its essence? Is it possible to conduct an experiment which demonstrates a phenomenon, get predictable results, explain the phenomenon with a mathematical formula, and yet, not be able to deduce the phenomenon's cause or reason?

Although Newton did not understand gravity he was able to quantify its actions (Significance unnecessary to mention!). This example of algorithm, not understanding, is paradoxical. Can we ignore physical intelligibility for the sake of mathematical description? Newton merely had a rule of computation and elevated it to a law of nature. Providing the mathematical description in the absence of the physical mechanism concerned great contemporary scientists and mathematicians, like Huygens and Leibnitz, who criticized Newton's accounts. Yet there are many mathematical algorithms standing alone and indefensible because we lack a complete physical understanding of its related concept. As Kline (1985) states, actually what we have found since Newton's day is "that our best knowledge of the physical world is mathematical knowledge" (p. 122). This suggests that it is unnecessary to have conceptual understanding and that teaching applications of algorithms is acceptable.

Given this scenario, one wonders if the social behaviorist's grip on mathematical pedagogy is so strong that the experientialist model will, at best, be rarely utilized? Perhaps it is because the social behaviorist's short term gains satisfy so quickly and the return on an investment in experientialism, although it may be greater, is not as quick to reward. The experiential model must be introduced from the beginning of schooling by teachers that understand the importance of developing the habits of a mathematical mind. For example, teachers who teach that any non-zero number divided by zero is undefined must encourage and be prepared to answer the question, "Why?". Dependence on algorithms, like dependence on calculators, is only useful if

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the answers they provide are reasonable to the problem-solver. The "reasonableness" of an answer can only be derived by a measure of ownership as it pertains to autonomous understanding.

Teachers often claim they do not know how to fit any more into an already overcrowded curriculum without having more time. One immediate battle to wage in the war against time involves homework. The battle involving homework, used as a weapon against the insufficient time available during class, can provide a service to understanding since it is not restricted by time. Without time limits students have the flexibility to research, study, discover, create, and understand. These are words which are not often used to describe the activities of "time-restricted" classrooms. Homework removes the restriction of time because it is not confined to a bell schedule. It is a license of freedom to understand governed by the learner. After a review of the literature on homework it has become more than clear that this potential use of homework is virtually overlooked by teachers, particularly in mathematics education. Where classrooms are confined by limits of time, the time a stud:nt can spend on their homework to extend classroom learning is relatively unlimited.

When has learning taken place? Regardless of the learning orientation, the teacher must evaluate the students' understanding of content. Since the social behaviorist has predetermined outcomes, criterion-referenced examinations are used as tests of "learning". In fact, the social behaviorist would advocate scientifically analyzing content and activities, translating them into behavioral objectives, delivering the content to change or modify behavior, and quantitatively measure "learning". Their delivery of content is that of direct training which seeks to teach facts, concepts, and skills using control and reinforcement in their stimulus-response theory. The social behaviorist believes this classroom management model is most efficient.

The experientialist must evaluate understanding using multiple assessments (quantitative and qualitative) since students do not use one method or approach in learning. Their outcomes are open-ended and sensitive to the individual learning styles of their students, therefore the methods used to determine mastery of content reflect individual growth and will generate genuine insights into what each student truly understands. It is

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precisely in accomplishing this genuine understanding that proponents of the experientialist model submit as sublime schooling.

Homework has its place in each model. For the social behaviorist, homework serves as drill and reinforcement of the prescribed criteria, helping students gain mastery of behavioral objectives. The student often asks the teacher, "Is this right?", verifying the control of the teacher, as the owner and authority of knowledge, and the students' dependence on him for confirmation of understanding. The experientialist uses homework to initiate and develop independence helping students gain ownership of understanding. The student develops a belief system that is compared not only to the teacher's but also to their peers.

A learner-centered homework model, which can also be used in a teacher-centered classroom, must recognize the importance of homework in relation to the philosophy of the learner-centered classroom. Homework should be purposefully challenging and develop problem-solving strategies. High expectations, regarding the quality of homework, should be modeled, established, and its integrity should not be compromised. Homework should exploit multiple learning styles to actively engage students in the discovery and application of concepts. Assessment of homework should enable teachers to diagnose students' needs and design learning activities to satisfy those needs. Homework should enable the growth of student responsibility by capitalizing on learner autonomy and develop belief systems as students construct an ownership of understanding. Homework discussion, in class, should make connections within and across disciplines, as well as provide opportunities for students to interact, demonstrate competency, or exhibit work.

To avoid the student becoming dependent on the teacher for solutions to the homework, the teacher should only isolate points of confusion. At the same time, if homework is to serve responsibility and understanding then it must have a plan. Adapting Polya's plan for solving problems in, "How to Solve It", these necessary conditions can be satisfied. With this plan, students are expected to "Go through the principle parts of your problem, consider them one by one, consider them in turn, consider them in various combinations, relating each detail to other details and each to the whole of the problem" (Polya, 1988, p. 33). The key features of Polya's plan involve four steps: (1) understanding the problem; (2) devising a plan to solve the

problem; (3) executing the plan to effect a solution; and (4) checking the solution. Students must realize that in solving a problem they must work from a problem state to a solution state. Students should find that working from the problem state to the solution state often involves a series of subgoals whose solutions are necessary in reaching the solution state. The application of Polya's plan is consistent with developing the kind of belief systems and dimensions of autonomous deeds that structure students' ownership of understanding. This "promotes students' confidence, flexibility, perserverance, curiousity, and inventiveness" (NCTM, 1991, p. 104).

What's the buzz? Tell me what's happening!

Often in education, we, in theory, attempt to justify a particular pedagogical philosophy using a syntax that reflects a peculiar order of constructed social reality. Yet often the theory is molded as much by external constraints (spatial, temporal, and contextual), as it is by it's own internal idealogy. Is the dominant teacher-centered pedagogical justification fabricated by inflexible scheduling and curricula, or have we the freedom to exercise our practice because of our theoretical beliefs? In recent education reform initiatives, the "buzz" suggests a pedagogical shift from teacher-as-owner-of-knowledge to teacher-as-facilitator-of-knowledge. This reform is radical change and will not likely take place in our educational classrooms; it opposes human nature. However, the "whisper" of change, through careful attention to homework, is quite possible. Sometimes the latest educational buzz spread by "buzzers of reform", upon closer inspection, is only a fly in the ointment. Subtle change, coupled with pre-service teacher education that is aligned with the philosophy and principles of the student-centered classroom, is more likely to accomplish what radical reform rhetoric cannot.

> Dead flies cause the ointment of the apothecary
> to send forth a stinking savour; so doth a little folly
> him that is in reputation for wisdom and honour.
> (Ecclesiastics X, I.)

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